V. FUTURE CONDITIONS

This section is provided to identify potential future changes in regional conditions that should be considered in developing and analyzing the restoration alternatives.

A. PHYSICAL

1. Sea Level Rise

The natural historical rate of sea level rise has been about 0.5 feet per century. There is now an international scientific consensus that global warming will cause an accelerated rise in sea level even if drastic actions are taken to reduce greenhouse gases (NRC, 1987). There is considerable disagreement on the magnitude of the change, or when a given change will occur. Predictions range from approximately 1.5 to 5 feet over the next century, or 0.5 to 2 feet in the next 50 years.

A rise of 0.5 feet would raise water levels in the tidal lagoon, and increase storm-surge flooding of areas seaward of the parking lot. Higher rises could bring tidal flows into lower Redwood Creek during spring tides, which could cause stratification and zones of brackish water in the lower dredged channel.

2. Earthquake Risk

In the next 50 to 100 years there is probably a small chance that there will be a similar earthquake to the 1906 event on the San Andreas Fault (the USGS reports a 2% chance in the next 30 years). However, it is almost certain that there will be a damaging earthquake greater than 7.0 magnitude on other faults in the Bay area (the USGS reports a 67% chance in the next 30 years). This could cause some changes in the levees and structures in the area.

3. Flood Risk

In the next 100 years it is almost certain that there will be a flood on Redwood Creek equal to or greater than the 1982 flood. This flood would inundate most of the study area, and would further erode the creek and pasture levees. Such a flood would probably cause the creek to shift course into the existing backwater channel.

4. Sedimentation

The management of the Redwood Creek watershed has improved in recent years, and damaging cattle grazing has been discontinued since 1990. It is therefore likely that sediment discharges to the wetland system will decrease. However, there will still be sediment deposition and filling as the creek discharges into the deep artificial channel near the footbridge.

B. ECOLOGICAL

1. Regional Conditions

Wetland habitats have been severely degraded throughout North America. The future does not suggest improvement. In California alone, only 450,000 acres of wetland remain of the original 4 to 5 million acres. Of the surviving 10%, most (62%) is rated by the California Coastal Commission as severely degraded (Barbour *et al.* 1993). The loss of wetlands in the California Central Valley is astonishing. Tule Lake was the largest lake west of the Mississippi River. It is gone. The San Francisco Bay Delta and the mighty Sacramento and San Joaquin Rivers are threatened remnants of an even more extensive wetland system. In Monterey Bay, despite the presence of the best coastal planning in the state, there has been a net decrease in wetland area in the last decade. This is after 90% of the Bay Area wetlands were lost well before the 1980's (Gordon 1979). The nearby wetlands of Bolinas Lagoon and San Francisco Bay suffered similar losses (Atwater *et al.* 1979). The apparent global decrease in amphibian populations is perhaps the best known symptom of widespread wetland loss.

Big Lagoon will remain an isolated wetland system in a regional landscape where wetland loss is already extremely high and is likely to be higher still. The migration of wetland species into the area has become more and more unlikely, because the regional pool of species and their populations have radically decreased. Successful colonization from the regional pool will apparently only become more difficult in the future. The Big Lagoon watershed is among a few coastal interfaces linking redwood forests with the rich boreal marine systems. These wetlands are unique in the world. The critical role they play in the natural history of threatened salmon and steelhead populations is but one example of their ecological and esthetic value.

2. Local Conditions

Big Lagoon is colonized by a large number of non-native species covering much of the former wetland habitats. If the present land use persists, and therefore water is drained from the local landscape as rapidly as possible, potential future increases in water to the system will probably largely irrigate alien species. They are likely to thrive as long as water is not ponded for significant periods permitting the re-invasion of wetland species. On the other hand, there has been a general improvement of land use along the riparian corridor and on the adjacent hillsides, and these areas

will probably continue to recover naturally. Cattle grazing has largely stopped. If direct action is not taken to remove some invasive species, particularly Kikuyu grass, these may expand and become a much more significant problem. None is more likely than the spread of Kikuyu grass. In the future, red foxes are likely to invade this area of coast, potentially displacing gray foxes and many birds. However, the present level of disturbance by people and dogs may be more significant and may persist at similar levels into the future.

C. LAND USE/RECREATION

1. Horse Use

An evaluation of existing conditions has indicated that there are impacts to natural values from the existing horse use of the lower Green Gulch fields. Impacts include erosion, overgrazing, water pollution, trampling of wetlands vegetation, loss of riparian vegetation, and potential impacts to special status species. Green Gulch Farm has initiated discussions with GGNRA regarding options to reduce the impacts of horse use on their land. Although Green Gulch Farm has informally agreed to continue to provide space for horses until 1999, at that time it could be continued, modified, or phased out. In 1993, GGNRA also initiated an evaluation of all stable operations in the park. Preliminary assessment of the Golden Gate Dairy stables on GGNRA land on the east side of Highway 1, indicates that further reduction of the level of horse use, and other management actions are necessary in order to retain a sustainable horse operation in this location.

2. Agricultural Use

Green Gulch Farm has indicated a desire to bring their lower fields (#6 and 7) back into agricultural use. Field #6 is not currently planted. Field #7 is presently used as horse pasture.

Identification of wetlands values, and important biological resources in the jurisdictional wetlands in the lower Green Gulch fields have prompted GGNRA to initiate discussions with Green Gulch Farm and San Francisco Zen Center regarding a conservation easement to allow cooperation in the management of these lands to better protect these resources. Possible actions which could result include fencing sensitive areas to exclude grazing, installing filtration strips to reduce water pollution from grazing animals, and other management practices.

VI. RESTORATION OBJECTIVES

A. GGNRA RESOURCE MANAGEMENT AND PLANNING OBJECTIVES

The following restoration objectives are based on GGNRA policy and goals for the Muir Beach area and Redwood Creek watershed:

1. Restore the historic wetland and riparian systems to the greatest extent possible given present day physical constraints. Restoration goals include reestablishing the physical, chemical, and biological components of these systems and the functions they served.

2. Restore a wetland that functions naturally and is self sustaining with maintenance requirements kept to a minimum. Design elements should accommodate these goals over both the short and long term.

3. Recreate habitat adequate for sustainable populations of special status species, including northwestern pond turtle, red-legged frog, salt marsh yellow throat, and coho salmon.

4. Develop design and management strategies to resolve water quantity and quality problems that limit restoration potential.

5. Identify incompatible uses and other uses which adversely impact existing and potential wetland and riparian values, or special status species. Identify design or management strategies to reduce those impacts.

6. Retain compatible recreational uses and eliminate, mitigate, minimize, or relocate others which are incompatible with wetland restoration.

7. Reduce flooding upstream created by artificial fill in lower reaches of the creek.

B. CALTRANS MITIGATION OBJECTIVES

The following are the objectives for restoration as required to provide mitigation for the repair of Highway 1 at Lone Tree Slide:

1. Develop a restoration plan that creates or enhances the functional equivalent of 3.6 acres of aquatic habitat as compensation for the loss of equivalent acreage of marina habitat.

2. The restoration plan should be consistent with GGNRA long-term objectives and policies for the site.

3. The restoration plan should address the concerns and requirements of the permitting agencies, including the Army Corps of Engineers, the State Coastal Commission, and the State Lands Commission.

C. TECHNICAL OBJECTIVES FOR WETLANDS RESTORATION

Based on current understanding of existing and future site conditions, the following specific technical objectives must be met to achieve the GGNRA and Caltrans policy objectives:

1. Design a wetland system that will function under the expected range of wet-season and dry-season freshwater inflows. To the extent possible, use natural features to control water flow on the site (as opposed to engineered control structures that require maintenance).

2. Design a system that can accommodate expected sediment inflows. The wetland should be able to adjust to large short-term sediment-deposition events during winter storms. Long-term sediment deposition should occur at rates that mimic the natural evolution of a wetland system.

3. Develop sediment control measures to minimize erosion and sedimentation during construction and revegetation.

4. Phase the project to minimize impacts of construction on existing habitats and wildlife, particularly special status species.

5. Account for expected changes in the future, including sea-level rise and expected land use in the Redwood Creek watershed.

6. Develop a revegetation plan that ensures high survival rates with minimal maintenance. This would be accomplished through proper soil preparation, plant selection, and timing of planting.

7. Improve conditions for anadromous fish by providing brackish water habitat for spring migrations and rearing habitat for juvenile fish during the summer low-flow periods.

8. Create and enhance freshwater wetland habitat for amphibians and reptiles. Freshwater emergent and submergent vegetation would be established in permanent ponds to benefit the western pond turtle and red-legged frog. Yellow-legged frogs may successfully invade if pools within the faster-flowing areas of Redwood Creek are created and enhanced.

9. Enhance western pond turtle habitat by establishing secluded haul-outs within the deep pools. Provide nesting sites for the turtle to encourage reproduction.

10. Identify the water quantity and quality impacts of land use activities within the Redwood Creek watershed, including stable operations, agriculture, and roads. Recommend management practices to reduce these impacts.

11. Identify recreational uses that interfere with wildlife breeding, refuge, and feeding.

12. Where compatible with wetland restoration objectives, provide additional flood storage to reduce flood peaks. Remove artificial levees and fill to improve the conveyance of the creek and floodplain.

D. LAND USE OBJECTIVES

The following objectives were used to guide development of land use and recreation alternatives to complement the wetland restoration alternatives.

1. <u>General Objectives</u>

- Develop restoration plans which are compatible with existing and future land use needs of Green Gulch Farm.

- Develop lagoon restoration plans which are compatible with land use/community development plans for the community of Muir Beach.

- Develop restoration plans which are compatible with planning for Frank's Valley, Muir Woods and other related recreational/open space facilities in the vicinity.

- Develop plans for the restoration of Big Lagoon which allow flexibly phased resolution of potential land use conflicts.

- Reduce the impacts of existing land uses to be retained.

2. Public Access

- Provide safe and clearly marked, publicly accessible trail connections with the surrounding trail system, in a manner that respects the desires and privacy of property owners, supports the restoration objectives and also serves the local community needs.

- Replace trails disrupted by the lagoon restoration in a manner consistent with the restoration objectives and the needs of trail users including the Muir Beach community.

- Ensure that the Muir Beach parking, trail system and beach continue to be welcoming and accessible to all park users.

- Develop lagoon restoration plans in a manner that will allow improved trail access along Pacific Way and not prevent future improved vehicular circulation along the road.

- Maintain public parking at existing levels in a parking lot located and designed with minimal conflicts with the restored natural system, and compatible with the needs of the community and other recreational users.

- Retain options for addressing parking lot issues not addressed as part of this planning effort.

3. Park Facilities

- Provide adequate restroom, picnicking and other park facilities for beach visitors which are accessible, sanitary, easily maintained and available all year. Retain existing parking lot capacity.

- Provide interpretive facilities with information which highlights visitor safety, natural habitat restoration, and habitat protection.

- Protect archeological and historic resources.

4. Community Character

- Maintain the existing natural, rural, open space and community character of the Muir Beach Community.

- Preserve the Dairy buildings and related horse/stable facilities on the east side of Highway 1.

- Maintain the horses in a manner visible to visitors and the community, but in less sensitive areas, and in numbers compatible with the wetlands.

VII. OPPORTUNITIES AND CONSTRAINTS

A. OPPORTUNITIES

1. Physical

- Excavated ponds could store water from high winter and spring flows, and provide critical wetland habitat during summer dry periods.

- Removal of levees and fill to create ponded water and wetlands in lower Redwood Creek would provide additional flood storage, and would reduce upstream flooding.

- Routing Redwood Creek into its historical alignment would allow the creek to develop a more natural geomorphic regime, and would reduce channel downcutting and bank erosion.

- Reduction or removal of horse grazing from the Green Gulch pasture would improve the water quality of the existing wetlands and lower Redwood Creek. Reduction of leakage from upstream septic tanks would further improve water quality, primarily by reducing coliform bacteria levels.

- Dissolved oxygen in existing ponded areas can decrease to undesirable levels. There is an opportunity to improve wind-induced mixing by increasing open water habitat and decreasing depths.

- The artificial channels draining Green Gulch are eroding and deteriorating. There is potential to enhance these channels to provide riparian habitat and reduce erosion.

- Acquisition and management of the Redwood Creek watershed by the State Park and GGNRA has reduced erosion and sediment loads to the system. The end of cattle grazing and other land use activities increases the likelihood that restoration efforts will be successful.

- Increasing the area of wetland and ponded water would increase the sediment storage capacity of the system, and allow the wetland areas to evolve at a more natural rate.

- Historic maps show a dune field and expanded tidal lagoon in the area northwest of the parking lot. There is the opportunity to remove fill from this area and import sand to recreate the historic dune field. This would also allow the tidal lagoon, which is currently constrained by the vegetated fill, to expand to a more natural size (about 0.8 acres larger than now).

2. Ecological

- There is potential to restore a diverse wetland system consisting of permanent ponds, seasonal freshwater wetlands, and an intermittently tidal lagoon. Historical data indicate that as late as 1853 the site supported about 12 acres of open water and seasonally-flooded wetlands, as well as over 13 acres of fringe marsh.

- The functional wetlands on the site currently exist as isolated, vulnerable fragments. Creation of a large contiguous wetland system would provide more extensive and resilient habitat for a variety of species.

- Removal of existing levees along Redwood Creek and the Green Gulch pasture would provide a direct connection between existing riparian and seasonal freshwater wetlands.

- Removal of some or all of the 6 feet of recent sediment and fill from Green Gulch pasture would substantially increase the area of open water and freshwater wetland habitat.

- Lowering the sediment delta elevation to allow infrequent pulses of brackish water into the restored wetland would discourage the encroachment of tules into open water habitat.

- Restoration of estuarine, brackish, and freshwater habitat at Big Lagoon would create a diverse ecological system capable of supporting a wide variety of species.

- The existence of small populations of red-legged frogs and western pond turtles indicate that the site could provide suitable habitat for these species. There is the opportunity to increase these populations by creating suitable breeding habitat.

- The existence of a relatively healthy anadromous fish run, as well as historical evidence of larger fish populations, indicates the potential to enhance habitat for anadromous fish.

- Creation brackish water habitat in the lower Redwood Creek area would provide transition areas for migrating fish, allowing them to adjust to increased salinity before entering the ocean.

- The end of cattle grazing permitted the partial recovery of riparian and upland habitat with the colonization of many native plants and animals over relatively large areas of historic native landscape. There are good opportunities to continue this recovery process by passive colonization and by more active landscape management such as control of alien weeds.

- Removal and control of alien species will permit much greater spread of native species in all wetland and upland communities.

- Land use improvements in Green Gulch can lead to significant recovery of riparian and pond habitats there, increasing the total area of wet landscape around Big Lagoon and enhancing many wetland and special status species.

- Wetlands feed and water more species than any other habitat type. They are sites of highest biological diversity and fundamental ecologic importance. Wetland restoration will thus improve the status of both wetland and upland species and particularly species of special concern. The survival of threatened and endangered species depends on wetlands first.

- While not a part of this restoration plan, elimination or reduction of upstream diversions from shallow groundwater would improve riparian habitat during the dry season, and would increase the survival rates of juvenile fish in the upstream reaches of Redwood Creek.

3. Land Use

There is an opportunity to address existing management and land use practices which result in degradation to natural values (wetlands and wildlife, water quality), and to identify ways to make desirable land uses compatible with preservation and enhancement of natural values.

- NPS and Green Gulch Farm could enter into a partnership for stewardship of land, restoration and enhancement where mutually agreeable.

- The community could participate in the restoration.

- Restoration would reshape existing desirable land uses in a manner that is sustainable and not in conflict with natural values.

- Restoration would provide an opportunity to improve trail connections between Muir Beach and park trail system.

- Restoration would add an educational component to the park experience related to wetlands and wetlands restoration.

- Additional buffer zones of riparian and wetland habitat would separate wildlife from recreational uses, and reduce conflicts.

B. CONSTRAINTS

1. Physical

- Adjacent homes, roads, facilities, and parking areas are at elevations as low as +10 feet NGVD. Restoration efforts should not result in increased flooding of these areas.

- Late summer flows in Redwood Creek typically drop below 0.1 cfs, and may be virtually zero in the late summer of drought years. Freshwater habitat will therefore be seasonal, unless permanent pools are created to store winter and spring flows.

- During drought years (such as the summer of 1992), minimum monthly inflow volumes can be as low as 2 acre-feet. This inflow volume would be exceeded by evaporation and evapotranspiration from wetland areas greater than about 12 acres.

- Low freshwater inflows will result in limited circulation during the late summer. During these periods restored ponds will have to rely on wind-induced mixing to maintain adequate dissolved oxygen levels.

- If elevations are lowered to allow occasional pulses of brackish water, backwater refuge habitat should be provided for freshwater species.

- Accelerated sea level rise could alter the functioning of the system by introducing tidal action to restored freshwater habitat.

- Large storm events will in the short-term alter the morphology of both Redwood Creek and the beach. The restored system should therefore be sufficiently flexible to account for dynamic changes due to flooding, sedimentation, and tidal storm surges.

- Sediment erosion rates from the watershed are approaching natural rates but are still elevated due to past and current land uses. The restored wetland should therefore be able to accommodate elevated sedimentation rates (which should continue to drop as the watershed recovers).

- Redwood Creek currently enters the site under the Pacific Way bridge. This bridge effectively fixes the creek at this point, and limits the length of creek that can be restored and allowed to migrate within its historic alignment.

- Excavation and lowering of wetland elevations could cause downcutting of the Redwood Creek bed as it adjusts to the new grade. This could increase sediment erosion upstream and possibly undercut the Pacific Way bridge abutments. The wetland restoration plan should include measures to minimize the effects of downcutting.

2. Ecological

- Existing jurisdictional wetlands in Green Gulch pasture, adjacent to the existing Redwood Creek channel, and near the tidal lagoon would be disrupted and altered by restoration efforts.

- Conversion of lower Redwood Creek to seasonal open-water wetlands would disrupt and alter existing stream habitat and up to 5 acres of riparian woodlands.

3. Land Use

- Existing land uses need to be accommodated, modified or relocated appropriately.

- Alternative pasture or paddock space for horses displaced by wetlands restoration need to be identified.

- Restoration and long-term protection of wetlands on land owned by Green Gulch Farm will require a conservation easement or other agreement between NPS and Zen Center.

- Land use requirements of Green Gulch Farm need to be incorporated into restoration plans (for instance, retaining Fields 6 and 7 and lots adjacent to Pacific Way for future agricultural use, and retaining a trail connection between Pacific Way and the Farm).

- Important trail connections need to be maintained or relocated.

- Options for resolution of other land use conflicts and future planning need to be preserved.